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THE BRITISH ASSOCIATION AT EDINBURGH.

THE meeting now closing has been in many respects a success, not marked by any startling novelties or the enunciation of any striking meteorological discoveries, but as we hope presently to show, well attended by meteorologists, several of whom had a good account to render of their labours during the past year.

The following is probably an incomplete list of meteorological observers present at the meeting, but it is not easy to render it perfect—

Adams, Prof. J. C., F.R.S. ... Cambridge.
Ainsworth, T. ..... Whitehaven
Backhouse, T. W. ..... Sunderland.
Ballot, Dr. Buys ..... Utrecht.
Bateman, J. F., F.R.S. ... London.
Belcher, Admiral Sir E. ... ,,
Birt, W. R., F.R.A.S. ... Walthamstow
Brooke, C., F.R.S. ..... London.
Brown, R. C., jun. ..... Carlow.
Buchan. A., F.R.S.E. ..... Edinburgh.
Colding, Dr. A. ..... Copenhagen.
Dowson, E. T. ..... Beccles.
Elliot, Sir Walter, K.S.T. ... Hawick.
Everett, Prof. J. D. ..... Belfast.
Glaisher, J., F.R.S. ... Blackheath
Grant, Prof., F.R.S. ..... Glasgow.
Healey, G. ..... Windermere.
Herschel, Prof. A.S. ..... Durham.
Home, D., Milne ..... Milne Graden.
Howden, J. C., M.D. ..... Montrose.
Hudson, H., M.D. .. .. Cork.
Janssen, M. J. ..... Paris.
Mackeson, H. B., F.G.S., Hythe.
Moffat, T., M.D., F.G.S., Hawarden.
Muirhead, H., M.D., ... Cambuslang.
Pengelly, W., F.R.S. ..... Torquay
Redford, Rev. F., M.A. ... Silloth.
Scott, R. H., F.R.S. ..... London.
Smelt, Rev., M.A. ..... Cheltenham.
Smith, Rev. H. W. ..... Kirknewton.
Smyth, J., jun., M.A. ... Banbridge.
Smyth, Prof. C. Piazzi, F.R.S. Edinburgh
Stevenson, T., C.E. ..... ,,
Stewart Balfour, LL.D., F.R.S., Manchtr.
Stirling, J. ... . Kippenross
Symons, G. J. ..... London.
Talmage, C. G. ..... Leyton.
Tomlinson, C., F.R.S. ... London.
Treutler, Dr. ..... Kew.
Vivian, E. ..... Torquay.
Whipple, G.M. ..... Kew.
Wilson, J.M., M.A. ..... Rugby.

The first communication of a meteorological nature was the report of the Kew Committee—probably the last, or the last but one, which will be addressed to the British Association, inasmuch as the control of the observatory is now vested in the Royal Society, and its maintenance provided for by the munificent donation by Mr. J. P. Gassiot, F.R.S., of the sum of £10,000. On a future occasion it may be our duty to consider the progress effected by those who are recipients of the large sums now available for meteorological research; for the present we pass on to give a few extracts from the report—

"*Meteorological work.*—The meteorological work of the Observatory continues in the charge of Mr. Baker.

"Since the Liverpool meeting, 113 barometers (including 17 aneroids) have been verified, and 2 rejected; 1320 thermometers and 215 hydrometers have likewise been verified.

"Two standard thermometers have been constructed for Owens College, Manchester, one for the Rugby School, one each for Profs. Harkness and Eastmann, of the Washington Observatory, four for Dr. Draper, of the New York Central Park Observatory, one for Major Norton, of the Chief Signal Office, Washington, one for Mr. G. J. Symons, and three for the Meteorological Committee.

"Three thermograph thermometers have been examined for Mr. Chambers, of the Colaba Observatory, and three for the Meteorological Committee.

"Two standard barometers have been purchased from Adie, and tested at Kew, one of which has been forwarded to the Chief Signal Office, Washington, and the other to Prof. Jack, of Fredricton, New Brunswick.

"Tubes for the construction of a Welsh's standard barometer on the Kew pattern, together with the necessary metal mountings, and a cathetometer, have been made under the superintendence of the Committee for the Chief Signal Office, Washington.

"The Committee have likewise superintended the purchase of meteorological instruments for Owens College, Manchester, and for the Observatory attached to the University of Fredricton, New Brunswick.

"The Kew Standard Thermometer (M. S. A.), divided arbitrarily by the late Mr. Welsh, and employed for many years past as the standard of reference in the testing of thermometers, was accidentally broken on the 3rd of January. Since then a Kew Standard, of the ordinary construction, made in 1866, and which had been compared on several occasions with M. S. A., has been used to replace it.

"Copies of some of the meteorological observations made at Kew during the years 1869 and 1870, have been supplied to the institution of Mining Engineers at Newcastle-upon-Tyne, and the Editor of Whitaker's Almanack, the cost of the extraction being paid by the applicants in both instances.

"A set of self-recording meteorological instruments, the property of the Meteorological Committee, have been erected in the Verification-house, and are now undergoing examination.

"Observations have been made with two of Hodgkinson's Actinometers, the property of the Royal Society, in order to compare them with the actinometers deposited at the Observatory, for reference, before forwarding them to India.

"A series of comparative observations was commenced in April, 1870, of two anemometers erected in the grounds attached to the Observatory, in order to compare the indications of a large and small instrument; but as a discussion of the result showed them to have been greatly affected by the influence of the neighbouring buildings, the instruments were dismounted in January last and re-erected in an open part of the park, at a distance from the Observatory. Three months' observations were made in this position, and as these proved satisfactory, the instruments have been dismounted. The cost of this experiment has been defrayed by the Meteorological Committee. Owing to his duties in Manchester, and to a railway accident, Dr. Stewart has not been able during the last year to devote much time to the Observatory. During his absence the most pressing duties were discharged by Mr. Whipple in an efficient manner.

Dr. CARPENTER, F.R.S., read a paper on the "Thermo-Dynamics of the General Oceanic Circulation"—

Before reading the paper, he mentioned that he had that morning received a letter from the First Lord of the Admiralty, intimating that it had been agreed that, on receiving a formal application from the Royal Society, the Board would be disposed to consider favourably his request for the fitting out of an expedition for deep sea exploration. The paper commenced by laying it down as a rule that the bed of the ocean below 2000 fathoms seldom attained a higher temperature than 32°. Where soundings had been made to the south-west of the Faroe Islands the temperature at that depth was 29°. This could not be attributed to depth

per se, for in the Mediterranean, which must be considered as an inland lake, the temperature at 2000 fathoms was 54°. In the Mediterranean, also, the fall in the temperature took place almost entirely in the first 50 fathoms, while below 200 fathoms, and down to the greatest depths, it remained exactly the same. Out in the Atlantic, on the other hand, and in the same latitude, there was a gradual and regular decrease in the temperature, after getting below the stratum warmed by the surface heat, down to the depth of 800 fathoms. Between 800 and 1000 fathoms there was a sudden fall in temperature of no less than 9°, while below the latter depth scarcely any difference was perceptible. This cold layer Dr. Carpenter attributed to the water chilled in the Polar areas sinking to the bottom by reason of its greater density, and from the same cause flowing southward and northward towards the Equator, while, at the same time, the surface water at the Equator was drawn towards the Poles to supply its place. There was thus at the same time an under-current of cold water flowing towards the Equator, and a surface current of warm water flowing towards the Poles. That the space occupied by the chilled water withdrawn from the surface could not to any extent be supplied vertically—*i. e.*, by lower strata rising from the bottom—he sought to show by the greater ease with which, in a large open area, it could flow in horizontally; and the configuration of the land explained how these surface currents were so much more observable in the North than in the South Atlantic. With regard to the Pacific the case was different, that ocean being almost cut off from the northern polar basin at Behring's Straits, and very little had as yet been ascertained regarding the Pacific currents. After branching out into its fan-like form, the northern half of the Gulf Stream could only be traced for a short distance north of Newfoundland, where its depth is not more than 50 fathoms. How came it, then, that near the Faroe Islands the temperature of the lower strata was only 5° lower than off the coast of Portugal, and the difference between the surface temperatures 16°? He explained it by the existence of a north-easterly stream of warm water flowing from the tropics independently of the Gulf Stream, the current of which, it had been agreed, was propelled by the prevailing trade winds. Dr. Carpenter explained his reasons for differing from Professor Wyville Thomson, who was associated with him in his recent explorations, and whose hypothesis was that the warmer water was supplied by bottom draught, and he closed by reading a letter from Sir John Herschell to himself, written shortly before his death, in which he recognised the existence of surface currents flowing horizontally to supply the place of colder water, as well as of those produced by the wind.

Sir W. THOMSON concurred generally with the conclusions come to by Dr. Carpenter. He pointed out, however, a case, where the supply of water would naturally be vertical rather than horizontal, viz., that of a closed channel or fiord, in which the water heaped up at the head by a surface current propelled by the wind, would form the head waters of an under current running in an opposite direction. These investigations of the deep sea and currents were of the greatest importance to navigation and in the laying of telegraph cables.

The discussion was continued by Professor STOKES, Professor FOSTER, and others, who in general coincided with the views expressed by Dr. Carpenter.

With reference to the influence of the temperature of the ocean currents on the working of telegraphic cables, Sir W. THOMSON mentioned that he had been informed by Captain Sherard Osborne that in laying a cable recently in the Eastern seas, it was found that where it was submerged in shallow water, and therefore in a high temperature, the transmitting power was greatly weakened; and where it crossed a deep portion of the ocean bed, the power was proportionately increased. He mentioned also, as an illustration of the existence of an under current flowing southward in the North Atlantic, that in laying one of the Atlantic cables, a buoy, with a long tail of rope attached, broke loose, and some time after it was found 10° farther south, in spite of the surface current of the Gulf Stream, the hypothesis being that it had been carried there by the cold current, into which the lower portion of the rope was dipped.

M. JANNSEN then read a paper entitled "Observations Physiques en Ballon," which, although long, and delivered with great volubility,

added very little to our previous knowledge of the phenomena of the higher regions of the atmosphere. Most of the observations had been made in balloons the property of M. Godard.

Report of the Rainfall Committee for the Year 1870-71,

Read by the Secretary, Mr. G. J. Symons.

"Your Committee have much pleasure in reporting that the organization under their supervision is believed to be in a generally efficient state. With a staff of observers numbering nearly two thousand, spread over the whole extent of the British Isles, there can, however, be no question that to ensure perfect efficiency and uniformity of observation, a systematic inspection of stations is absolutely necessary. In a paper read before the Society of Arts in 1858, Mr. Bailey Denton appears to have considered that there should be one inspector to about each 200 stations. At that rate we ought to have ten. The Meteorological Committee of the Royal Society also make it a rule to have all their stations inspected each year. On the most moderate computation it is indisputable that at least one inspector of stations is required, the whole of whose time should be devoted to travelling.

"Ever since their appointment, your Committee have felt and acted upon this conviction, but want of funds has prevented them from employing a regular inspector, and obliged them to rely solely upon the unpaid services of their secretary. Even under these adverse conditions, considerable progress had been made with the work, and upwards of 400 gauges had been visited and examined previous to the Liverpool meeting. At that meeting, however, the Association only granted half the sum for which we asked, and we have consequently (most reluctantly) been obliged to stop this important and useful work.

"As an interim measure, and with a view to ascertaining in what districts inspection is most requisite, it has been suggested that a schedule of questions as to the position of their rain gauges should be sent to every observer. The committee unanimously approved of the suggestion, and annex copy of the circular and schedule they are about to issue.

"Another branch of investigation which has been arrested by the same cause, is the relative amount of rain falling in different months, or as we usually have termed it, the 'monthly per-centage of mean annual rainfall.' Several articles upon the subject have appeared in our previous reports, and last year we pointed out that the observations for the decade 1860-69 offered data of completeness unparalleled either in this or any other country, the result of which we had hoped to submit to the present meeting. Excepting in our own reports, we are not aware that the seasonal distribution of rain in this country has received any attention, while on the Continent it has at all times been looked upon as almost equally important with the gross amount.

"Although several short and interrupted sets of observations have

been made in northern Derbyshire, the rainfall of that hilly district has not hitherto been examined with the thoroughness which its importance deserves. We have in previous reports urged the desirability of several additional stations being established, and as no one else undertook the work, our secretary did so, and by the assistance of the observer at Buxton, and Mr. Hazlewood, of Castleton, was enabled to commence several sets of rainfall observations in the district. Some others are still required, which, if our funds permit, we intent to add.

"*Pit gauges.*—In our last report we drew attention to the fact that a gauge of which the orifice was horizontal, level with the ground, but in a small pit or excavation, had at Calne collected about 5 per cent. more than one of which the receiving surface was one foot above the ground. Whence it followed that as a great many rain gauges (the majority in fact) are placed with their apertures a foot above the surface, the records of all these gauges were below what they would have been if placed in a pit as just described. We gave some reasons which appeared to us to prevent the general use of pit gauges, and added the following concluding remark :—'This result appears so startling, that further experiments will be conducted on the subject.' The funds at our disposal have not allowed us to do so, but fortunately the Rev. F. W. Stow, M.A., has tried one pair of gauges mounted in this manner at Hawsker, on the Yorkshire coast, a few miles south of Whitby. The following are the results during 1870 :—

Experiments with Pit Gauges.

	Hawsker, 1870.			Brit. Asso. Report, 1869-70	
Months.	5 in. gauge at 1 foot.	5 in. gauge in pit.	Ratio.	Calne, 1866-7. Mean ratio.	Difference.
January	1·610	1·770	110	113	— 3
February.....	1·995	2·300	115	109	+ 6
March	1·052	1·293	123	107	+16
April	·370	·390	105	105	0
May.....	...	...	...	...	...
June	2·650	2·705	102	102	0
July.....	·920	·977	106	103	+ 3
August	1·887	1·908	101	103	— 2
September ...	·845	·934	110	103	+ 7
October	5·000	5·053	101	102	— 1
November ...	3·043	3·234	106	106	0
December ...	5·230	6·420	123	108	+15
Totals	24·602	26·984	.....	.....	.....
Means	.....	.....	109·3	105·5	+3·8

"Of course it was not to be expected that the results of a single year should agree exactly, with the mean of two other years, still less when the size of gauge used was different, and the locality so opposite as the inland district of Calne, and the rock-bound Yorkshire coast. We therefore look upon it as satisfactory that in only four months out

of eleven do the ratios at Calne and Hawsker differ more than three per cent. In April, June and November they are identical. The Calne results are thus strongly confirmed, and it may be considered as certain, that pit gauges always exceed those at one foot, although the precise amount of excess remains to be determined.

"In our last report we expressed the hope that we should this year be able to state the result of the discussion of all the rainfall registers which were absolutely continuous from January 1st, 1860, to December 31st, 1869. We have the pleasure of doing so in two respects, viz., (1) with reference to their bearing on the question of the existence or otherwise of secular variation of rainfall in the British Isles, and (2) data indicative of the distribution of rain over the country.

"The secular variation of rainfall, or the relative dryness and wetness of different years, and groups of years, is one of the most important and difficult branches of rainfall work. It has been treated in our reports for 1865, and very fully in that for 1866. In the latter, we gave the calculations in detail from which the values from 1726 to 1865 shown on the accompanying diagram were obtained. Referring to that report for full explanation, we have only now to mention that the subsequent years, 1866 to 1869, have been computed in the same manner, and added to the diagram. We may also remark that various observations collected since its publication have confirmed the general accuracy of the curve quite as much as could have been anticipated. On the present occasion we do not intend to discuss the relative rainfall of different years, but the relation of the fall during the ten years 1860-69, to previous decades. For this purpose we have grouped the yearly values in decennial periods, similar to those adopted in our 1867 report.

"Having previously pointed out the peculiarities of the earlier portion of the curve, it is only necessary on the present occcasion to call attention to the last forty years, whence it will be seen that according to this mode of investigation (which is principally based on English returns,) three out of the four decades had a rainfall nearly identical, and the other (1850-59) considerably below them, the deficiency being nearly 7 per cent.

"This result is based on a combination of records, as fully explained in our 1866 report. We proceed to examine how far it is corroborated by individual stations, but are at once confronted by the paucity of stations of which perfectly continuous records for even half a century exist. We therefore confine ourselves to the forty years from 1830 to 1869, for which period we have twelve perfect records at widely separated stations. The mean fall in each decade and in the whole period, and the ratio of each decade to the whole period at each station are given in tables, and laid down on accompanying maps.

"From careful examination of these tables, it appears that the amount of rain which fell in the ten years 1830-39, was very similar to that which fell in the ten following years, the difference being a decrease, but scarcely one per cent. The investigation in our 1866 report shows an increase of 1·2 per cent., and examination of returns ceasing in

1850, and therefore not quoted in either report, show several cases of absolute identity.

"With one investigation leading to a decrease of 1 per cent., another to an increase of the same amount, and a third to identity, we are led to the conclusion that the two decades may be considered to show similar results. This is a much more important fact than it at first appears, and for this reason. While there are only about a dozen registers complete for the four decades, there are 38 which are complete for the last three decades. Now that we have found the relation between the first two decades, the returns for the thirty years are rendered almost as instructive as those for forty years.

"We have therefore compiled another table which differs from the former only in its being for thirty years instead of forty, and in giving observations from thirty-eight stations instead of twelve. The relative rainfall of the three decennial periods therein given, viz., 1840-49, 1850-59, and 1860-69, is shown on the accompanying map by the generally somewhat V shaped curves. We say generally, because at 26 stations out of 38 (2 out of 3), that is more or less acutely the form taken by the curve. Whence of course it will be seen at once that the rainfall of the second decade (1850-59) was less than either that which preceded or followed it. Now if we refer to the curve given by the calculations made in 1865, we shall find an almost identical depression, which strikingly proves the trustworthiness of the method then adopted.

From the above table and diagram the remarkable similarity of the results obtained by the two dissimilar modes of investigation is rendered so obvious, that it is unnecessary to dwell further upon it. We therefore proceed to the second part of our investigation, namely, to consider the distribution of the rainfall of the last decade, during which we have nearly four hundred perfect sets of observations. As each set of observations comprises more than a thousand entries, and the following table contains the result of nearly half a million observations, it is probable that it contains some slight per-centage of errors, but we have no suspicion of the existence of any which appreciably affect the results.

"Before accepting the decennial averages, 1860-69, as data indicative of the distribution of rain over the country, we wish to offer a few prefatory remarks. The difference between the amount collected by any two rain gauges depends on at least four separate and distinct conditions, three of which must be ascertained and corrected before the fourth can be accurately determined.

"The conditions are—(1) Length of series of observations; (2) Correction for secular change; (3) Height of gauges above ground.

(1) Even if there were no other evidence in existence than the large diagram of the fluctuation of rainfall already referred to, we feel that it would sufficiently prove the impossibility of determining accurately the rainfall at any place except by observations continued over a long series of years at that place, or by differentiation from some proximate long continued series,

(2) It does not follow that simultaneous observations even for ten years, giving for example a mean difference between two stations of 5 inches, prove that the rainfall at the one station is greater than the other by that amount—although, if they are not very distant the one from the other, it would probably be a safe assumption. Proof, however, of the existence of risk in the matter is afforded by the fact that although there is great general similarity in the V shaped curves on the map, there are hardly two which are strictly identical.

(3) Before mean results can be given with any pretensions to accuracy and finality, they must be corrected for the elevation of the rain gauge above the ground.

"The above remarks sufficiently show that the mere average of the fall of rain measured during ten or more years does not necessarily give the true mean rainfall at that place.

"Let us take as an example the highest amount recorded in the table and on the map—Seathwaite—which had during the ten years, 1860-69, an average of 154 inches. Many persons would say at once that that was therefore the mean rainfall at that station. It is, however, nothing like it. From the abstract of Table III., it will be seen that the rainfall over England generally during those ten years was 1·5 per cent. above the average; upon which evidence we are bound to reduce the observed mean in that proportion, and then the average becomes 152 in. Even this, however, is not correct, for we pointed out in condition (2), that the same years or groups of years are not similarly wet in all parts of the country. Referring, therefore, to Table IV, we find that at the nearest station to Seathwaite, Kendal, the decade in question was 7 per cent. above the 30 year mean; hence, on the supposition that the Kendal values are applicable to this station, we have to reduce 154 inches by 7 per cent. instead of 1·5 per cent., and hence the probable mean comes out 141·8 inches.

"Now most fortunately we can test the accuracy of this calculation in three ways:—

(1) The mean fall at Seathwaite in the previous decade, 1850-9, was 126·98; from the Kendal observations the fall in that decade was 10 per cent. less than the mean, therefore ($\frac{126·98}{0·90} = 141·09$) we find the probable mean comes out 141·1 from this decade, and 141·8 from that of 1860-69. They thus agree within less than an inch, or one-half per cent.

(2) The fall at Seathwaite has now been continuously observed for 26 years, viz., from 1845 to 1870 inclusive; the mean of the whole 26 years' observations is 140·03.

(3) This value, corrected according to the table in our 1866 report, becomes 141·44, agreeing *exactly* with that indicated by the decades 1850-59, and 1860-69.

"This example proves three points, (1) the great degree of accuracy which is attainable by proper methods; (2) the care requisite to secure it; (3) the serious errors inseparable from the use of mere arithmetical averages without reference to secular changes.

These observations must of course be taken as general results, and

not be construed as having any bearing on the relative rainfall even of proximate stations, the amount of which will vary considerably, according to local circumstances.

"Hence it will be seen that the probable average at Seathwaite is 141 instead of 154in. as shown on the map, or 7 per cent. less. A similar but generally less correction may be required for other stations. The figures must not therefore be considered as showing the probadle mean fall at the several stations, but only as approximations generally pretty close. The data in our possession, if corrected in accordance with the method explained, would afford more accurate results, but the investigation is altogether beyond our present resources.

"Large tracts of Ireland and even of Scotland are left blank in the present map for want of observers. Much has recently been done to remedy these deficiencies, but there are still many localities where observations are deficient; we shall gladly receive any offers of assistance from those who have residences or property in those parts, and our Secretary will readily advise them as to instruments.

THE DECREASE OF RAINFALL WITH ELEVATION.

To the Editor of the Meteorological Magazine.

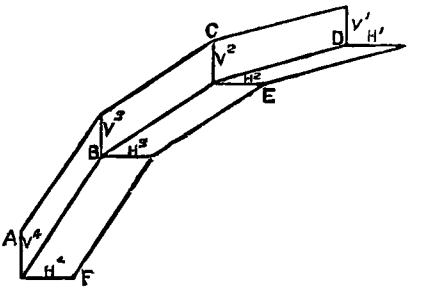
SIR,—I am surprised to find how easily the question is settled. Knitting needles, foot rules, strings, and a few parallelograms, as a mathematical sauce, are the potent weapons of common sense; and just as I was expecting to hear that the complicated problem admitted of no solution at all, owing to the want of facts to go upon, I find that neither facts nor mathematics are necessary, and that all is perfectly simple and obvious. I certainly am constrained to ask, Have not these gentlemen overlooked the difficulties of the problem?

One most important condition has been ignored by all of them—I mean the inequality of rain-drops. I don't suppose any two are exactly alike. If they were all equal, no doubt they would pursue similar paths. But they are unequal: they are differently affected by the resistance of the air, and therefore fall with different velocities, and are deflected by wind to a different extent. No doubt, also, they increase in size as they fall by coalescence. I really think that it is not too much to say, that the great irregularities thus caused render both knitting needles and parallelograms altogether inapplicable to the case.

But of one thing I am sure, that, if these diagrams are applicable to the case of horizontal gauges, they will do just as well for vertical gauges if turned on one side, as hard-hearted masters do with the figures of Euclid to puzzle boys. It certainly strikes me as a somewhat revolutionary doctrine of Mr. Du Port's (if I understand him at all), that parallelograms on equal bases and between the same parallels are *not* equal, if the bases are vertical instead of horizontal. Yet what else can he mean by saying that the properties of a parallelogram dispose of my question, "Why not for vertical, or gauges at any angle"?

I never heard that the properties of a parallelogram would tumble out of it if turned upside down; but I am open to conviction, and if convinced, I promise in future to label my diagrams, "With care, this side up."

It seems, then, that you cannot deny that the angle of rainfall influences the amount caught in a horizontal gauge, and yet think that it stands to reason that it must influence the amount caught in a vertical gauge. To make this perfectly clear, look at this diagram,



where if H_1, H_2, H_3, H_4 are equal, V_1, V_2, V_3, V_4 are not less so. It must influence both or neither. And those who say, "Neither," must find a cause to account for an increase in vertical gauges as well as a decrease in horizontal ones, or else separate and opposite causes, one acting only on vertical, and another only on horizontal gauges.

But I wish to point out to the upholders of the old theory, that if they are ever so little wrong, angle will affect the amount caught. If, in practice, the rain-drops quit ever so little the path which these gentlemen have, without the slightest basis either of fact, or even of thorough theory, mapped out for them, if by any chance they do not separate as they fall quite as much as they ought to do, what is the consequence? Why, a decrease with elevation in horizontal and an increase in vertical gauges. It is quite a mistake to suppose that I have ever maintained the *exact* truth of the much-abused assumption or "axiom." I said that the calculations were made on that assumption: but if it is only roughly true, the calculations will still be approximately correct, and obliquity will still be the cause of decrease and increase, though in that case the decrease and increase will be somewhat irregular, and the amount calculated for a gauge at right angles to the rain will not be the same at all heights. This, I may say, pretty accurately represents the actual facts furnished by my experiments, so far as they are worked out. And I am sure from the very fair and temperate letters of Dr. Burder and Mr. Du Port, that they will agree with me that any clear result of experiments, when fairly ascertained, ought to outweigh any pre-existing theory unfounded upon experiment, even when adopted, long previous to experiment, by so great a man as Sir J. Herschel.

I see that no one has taken up my challenge to explain the results of my "Position Series," on the supposition of the angle of fall not affecting horizontal gauges.

But I had almost forgotten what Mr. Du Port calls a crucial test of the correctness of Dr. Burder's theory. I always like to hear of a crucial test. Well, here it is. The secant of 90° is infinity and the cosine of course nothing. Very good. I haven't the slightest wish to quarrel with infinity or nothing. Therefore the gauge catches nothing. Excellent! Then, after all, the amount which a gauge catches is the "physical expression of a fact" regarding the secant or cosine of an angle. I am delighted to hear it. It is exactly what I have said myself. Now, tell me, does the cosine or secant remain the same from 0° to 89°, and make a sudden rush into annihilation or infinity at the moment 90° is reached? Unfortunately it does not; neither, as I maintain, does the amount which a gauge catches.

I am, Sir, your obedient servant,

FENWICK W. STOW.

Hawsker, July 19th, 1871.

To the Editor of the Meteorological Magazine.

SIR,—With your permission I venture to make a few remarks on the above subject:—

To prove the truth of the theory, that the register of a smaller amount of rainfall by a horizontal gauge, at an elevation, than by a similar gauge on the ground, is the effect produced by the greater strength of wind at the elevation; that eddies around the gauge blow away a portion of rainfall (see *Meteorological Magazine*, No. 65, page 72), I conceive that we want the best plan of so placing at an elevation a horizontal gauge, that it shall be shielded from the wind, and at the same time catch all the rain. There is no doubt but that the ingenuity of those interested in the result will soon obtain this desideratum.

Have we not found the above-mentioned theory supported by the close agreement of the returns of two gauges tipped at 45°, at the elevations of 6 and 30 feet respectively? May it not be that by reason of the wind driving more perpendicularly into the mouth of a tipped gauge, we get rid of the disturbing eddies?—Yours truly,

G. WARREN.

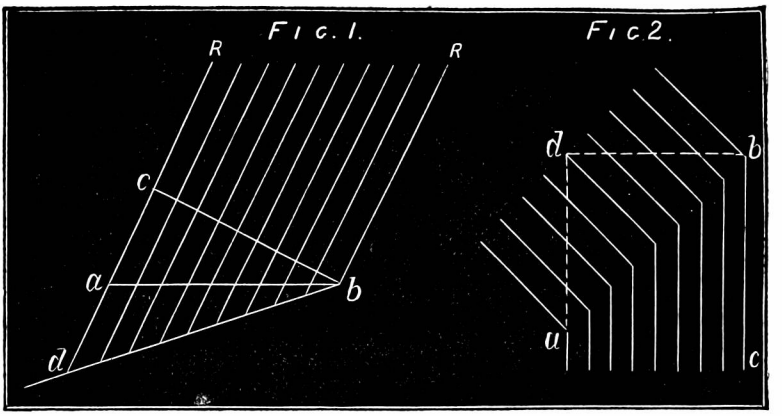
Merton Villa, Cambridge, July 21st, 1871.

To the Editor of the Meteorological Magazien.

SIR,—The correspondence which has been published in the *Meteorological Magazine* respecting the decrease of the rainfall with elevation, calls for a few remarks.

Dr. Burder, in his letter dated April 25th, 1871, supposes a cloud discharging rain uniformly from a square mile of its lower surface, and argues thereon not altogether correctly, in my opinion. If the rain fall *vertically*, the ground watered will be a square mile in extent, but only provided that it be *level*; it will actually be greater than a square mile if it be uneven. If the drops become *suddenly deflected* by a current of air to an angle of 45°, and maintain that direction until they reach the earth, the space of ground watered will be less than,

equal to, or greater than, a square mile, according as the ground slopes, so that the rain strikes it at an angle greater than, equal to, or less than 45°. Fig. 1 illustrates this, R R the direction of the shower,



here drawn at an angle of 22° from the vertical; *b c* rising, *a b* level, *b d* sloping ground; and it is evident that *b c* is less than *b a* and much less than *b d*; also that *b c* is least when the rain strikes it at right angles. Therefore, in order that a rain gauge shall fairly measure the amount of rain deposited on the ground surrounding it, the inclination of its aperture should be parallel with the slope of the ground. But if it be required to ascertain the maximum possible amount of rain that can be collected by a given aperture, that aperture must be kept facing the showers, and this could only be achieved by a rotating tilting gauge—an instrument which is difficult to construct so as to work satisfactorily.

While vapour exists in the form of cloud it is borne along by the air current in a horizontal direction, or nearly so. When condensation occurs, the atoms have an initial horizontal motion, and come under the influence of the wind, a variable force, and of gravitation, a uniformly accelerating force, and the resistance of the air to the descent has also an effect. Under these circumstances there is no more reason to assume that the deflection of the rain takes place in a level plane than in an oblique plane. If, as Dr. Burder supposes, in his letter dated July, 9th, 1871, at a certain *level*, the direction of all the rain-drops be deflected, preserving their parallelism, the drops are brought closer together with respect to a surface placed at right angles to the course of the drops, and a *horizontal* gauge might be expected to collect the same quantity, whether placed in the oblique or the vertical course of the shower. This is a very pretty illustration, but it is deceptive and inconclusive, for we have only to vary the supposition to get a different result. Suppose, instead of the direction of the rain-drops being changed at a *level*, it be changed at an oblique surface, as in Fig. 2, where the change of direction is supposed to take place along *a b*. A horizontal gauge would collect very different quantities in the different courses of the shower. At *d b* it would catch five drops to nine at *a c*.

The force of the wind being generally less near the earth's surface than in the cloud region, while the force of gravity increases as the earth is approached, it seems evident that the drops must have a more oblique path in the higher than in the lower regions of their flight. Nevertheless, this mode of illustration appears to me unsatisfactory, and beset with difficulties.

One point, however, seems, from amid all this discussion, to become clear, which is, that if we wish to measure in our rain gauges the depth to which the rain would lie on a horizontal surface, if it all lay as it fell, we must select such a position for the gauge that its aperture when level, shall have a perfectly clear horizon, there being no elevations to intercept the rain from any direction. As this condition can hardly ever be secured, the next best thing is to attain it as near as possible.

Yours faithfully,

RICHARD STRACHAN.

11, *Offord-road, London, 24th July*, 1871.

To the Editor of the Meteorological Magazine.

SIR,—Since writing my letter of the 24th inst., you have been kind enough to direct my attention to the Memoir on Rain, by Flaugergues, in *Annals of Philosophy*, vol. xiv, which is a translation from the original in *Bibliotheque Universelle*, vol. viii; and I think it right to state that Flaugergues therein shows that the quantity of rain which falls upon a given horizontal surface is porportional to the sine of the angle of incidence of the drops. In this way he accounts for the remarks of Lord Charles Cavendish and Dr. Heberden (*Phil. Trans.* vol. 69), that the quantity of rain which falls upon the same surface at the top of a building is less than at the bottom of it, adding—"The rain at the top of the house, or any other part completely exposed, experiencing without obstruction the whole action of the wind, must assume a direction inclined to the horizon, and reach the rain gauge placed there in that direction, but if the rain is screened from the action of the wind by the building, the drops gradually losing their inclined direction by the resistance of the air, must fall into the rain-gauge placed there vertically, or nearly so."

Mr. Meikle refuted this explanation by an argument similar to Dr. Burder's, founded on the supposition that the deflection vertically of the rain drops takes place in a horizontal plane (vide *Ann. of Phil.* xiv. 312; xv. 270; and xvi. 422). His letters are worth reading if only on account of the animus with which he carried on the discussion with Messrs. Holt and Boase. The latter gentleman effectually non-plussed him by very prudently taking care not to trace all the rain-drops from the same height, although Mr. Meikle affected to treat the notion as a self-delusion.

Verily there is nothing new under the sun! I readily grant priority of idea to Mr. Boase; perhaps Dr. Burder will as willingly yield equal credit to Mr. Meikle?

Yours faithfully,

R. STRACHAN.

11, *Offord-road, N., 29th July*, 1871.

RAINFALL RULES.

Rule I.—We think that the dissimilar results obtained by Messrs. Cator and Stow may be set off one against the other, and that at present no sufficient ground has been shown for altering the wording of this rule, which was intended for all parts of the country, but to which there are of course local exceptions.

Rule V.—Mr. Stow's suggested addition, might, we think, be accepted.

Rule X.—To Mr. Cator's proposed addition to this Rule we entertain the strongest possible objection, except in so far that it raises in a distinct form the question, Is it, or is not, desirable to read to thousandths of an inch?—a question indirectly raised also by Mr. Bicknell. In experimental work, and with the delicate appliances employed for instance by Mr. Chrimes, thousandths of an inch of rain have a necessary individuality, but with ordinary observers we consider their measurement approaches a farce. We are aware that in saying this we are censuring our own private practice, and enlisting the opposition of several first-rate observers, Mr. DuPort (*Meteorological Magazine*, Vol. III. p. 178), Mr. Vernon, id. p. 179; Mr. Bicknell, and Mr. Cator (Vol. VI. p. 27), probably also Mr. Stow and Mr. Mawley.

A proposition of this kind being once distinctly made should, we consider, be fully discussed and settled; we shall, therefore, endeavour so to classify our objections that those who think otherwise may meet each objection separately, and thus avoid discursive remarks.

(1.) *Existing practice.*—By examining 400 returns from different districts, we find that there are

8	returns	giving	readings	to	0·1	inch.
355	,,	,,	,,	,,	0·01	,,
36	,,	,,	,,	,,	0·001	,,
1	,,	,,	,,	,,	0·0001	,,

whence it is evident that not one tenth of the observers do read to thousandths, therefore, the proposed rule would require nine times as many persons to change their practice as the present rule does; which shows that existing practice is against the proposal, by 9 to 1.

(2.) *Scientific authorities.*—All the returns published by the British and Scottish Meteorological Societies, by the Astronomer Royal, the Registrars General of England and Scotland, the British Association (except experimental work), the Weather Reports of the Meteorological Committee of the Royal Society, give the readings to hundredths, and not one of them to thousandths. Hence if we accepted the proposed alteration it would render us the only body professing that degree of minuteness, and break up the present uniformity of practice.

(3.) *Difficulty of reading to* 0·001 *in.*—Owing to its small linear value. It is extremely unusual to meet with a gauge which multiplies the real depth more than 20 times, 10 or 12 is most frequent, but to put our case in the light least favourable to ourselves we take 20 times, which makes each thousandth of an inch represented by a fiftieth of a linear inch. Passing over the question of placing the glass upright by a spirit level (which Mr. Bicknell admits, Vol. VI, p. 27), we come to

the question whether two observers can be found who would agree in their readings to 0·001 in. This point we also pass over, referring our readers for an illustration to the letter by another advocate for 0·001 (Mr. Stow), in our April number, where he says "Rule XII. involves a distinction between ·005 and ·004 which with nine glasses out of ten I am unable to make, owing to the irregularities of the bottom."

(4.) *Records filled up to* 0·001 *imply a degree of accuracy which is not at present attainable.*—By this we mean that there are sources of error, each of which separately exceeds, and all of which together largely exceed, the proposed unit of measurement. We may mention a few: (*a*) very few rain gauges are at present divided with sufficient accuracy, and, therefore, every gauge must be tested to thousandths of an inch, they must be specially constructed to stand this test, or every rainfall reading must be corrected for instrumental error. (*b*) Before a reading of the amount of rain is taken it is diminished by the following causes: (1) the surface of the funnel and of the pipe must be wetted before any will run down the pipe, (2) the collecting vessel, be it bottle or can, must be partially wetted both by the ingress and emptying of the water, (3) the same remark applies to the measuring glass. Now taking an ordinary 5 inch gauge we have for (1) more than 20 square inches, for (2) at least 5, and for (3) 2, giving a total surface of 27 square inches to be wetted before a drop is measureable. How much will it take to wet this area? Would a quarter of a teaspoonful be too much? we think not, but a quarter of a teaspoonful represents three times the proposed unit of measurement; which as pointed out by Mr. Arnold is five drops of water for a 5 in. gauge. If this does not carry the argument far enough, let us for an instant refer to the 1 in. experimental gauges, where a single rain drop of moderate size (weighing one grain) equals six times the proposed unit of measurement.

Rule XII.—Messrs. Mawley, Bicknell, Cator, and Stow, have recently objected to this rule. We accept not the responsibility of its defence; it was altered in December, 1868, in consequence of a discussion in these pages, and it turns upon questions of thousandths of an inch, of which we have just indicated our opinion.

Rule XV.—Mr. Bicknell's objection to this rule is replied to by Mr. Arnold. There are several arguments in favour of Mr. Bicknell's proposal, but our own opinion is at present adverse, and it is so mainly because the loss from a rain-gauge funnel so imperfectly represents the loss from the earth's surface, which of course depends on soil, shelter, slope, crops, &c. Could not the comparison be made?

Mr. Cator says we should state how the snow is to be melted. There is apparently no objection to this; but, as pointed out by Mr. Stow, it is hazardous to put hot water into frosty glasses; we should therefore recommend that the word "warm" be substituted for "hot." We cannot accept, without further discussion, Mr. Stow's proposal to "strike out section 3 of Rule XII. as delusive, sometimes it would not give results correct to the nearest inch of rain." Would Mr. Stow mind giving us an illustration of this, showing also which of the gauges in ordinary use would, under the same circumstances give a correct result?

These rules have been submitted to perhaps the most severe ordeal it is possible to conceive—viz., unlimited criticism by nearly two thousand persons, all of whom are under a sort of mutual obligation to conform to them, and who are, individually and in the aggregate, probably the most competent persons in the world to criticise them. However, the result has been that scarcely half-a-dozen persons have objected to or suggested improvements in any of the rules. Mr. Cator favoured us with a string of suggestions, some of which seemed to us so good that we assumed the responsibility of inserting them in "British Rainfall," 1870 (p. 129), without further discussion. His others, and all the other letters which we have received upon the subject, have been printed in previous numbers of this Magazine. We now contribute our share to the discussion, not with the least wish that it should have any weight beyond that of other observers, or that it should be exempt from that criticism which we have scattered right and left upon some of our most able correspondents and best friends.

REVIEW.

The Geographical Distribution of Heart Disease and Dropsy in England and Wales. By Alfred Haviland, M.R.C.S., &c. Folio, 61 pp. and large map. W. & A. K. Johnston, London & Edinburgh.

THIS work is one the importance of which we do not think anyone is in a position to realize, but, in the first place, it shows that though two of the foremost men in Medico-Climatology, Sir James Clark and Dr. Scoresby-Jackson, have been taken from us, there are other hard and able workers who will worthily follow in their steps.

The work is got up with the accuracy for which the publishers are well known, and being based on the localities of nearly a quarter of a million deaths from heart disease and dropsy, has apparently an unassailable basis of facts. It is beyond our province to discuss the medical aspect of the question, but the coloring of the large (about 40 in by 30 in.) map is so clear and simple that no one can fail to understand the whole argument, or to be able to verify for himself the conclusions arrived at by the author, the bearing on which of meteorology may be imagined from the following paragraphs:—

"I think that the coincident phenomena displayed in the foregoing pages point to some *materies morbi* resident in certain localities, perhaps in all; the only difference being that one district is frequently purged by the beneficial influence of the sea winds, whereas another is sheltered so as to admit of an accumulation; this accumulated air sewage may have either an animal or a vegetable origin, or both; it is impossible to say. All that we know is, that it is coincident with excess of rheumatism, and excess of mortality from heart disease.

"I do not think that the influence of the sea winds on the mortality from heart disease is altogether physical. I incline to the view that there is a chemical element as well in operation. I think that ozone may not play an unimportant part in destroying the material of rheumatism; if so, in the wards and chambers where cases of rheumatic fever lie, we should not only take care that the ventilation is perfect without draught, but that the atmosphere is impregnated with artificially formed ozone; this experiment I feel is worth a trial. I know its efficacy in fever."

JULY, 1871.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1860–5	Greatest Fall in 24 hours. Dpth	Date.	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Date.	Min. Deg.	Date.	No. of Nights below 32° In shade	On grass.
			inches	inches.	in.								
I.	ENGLAND.	Camden Town	4·13	+ 2·34	1·23	10	18	80·0	18†	45·8	31	0	0
II.		Maidstone (Linton Park)	2·84	+ ·86	1·02	11	18	84·0	19	48·0	31	0	...
,,		Selborne (The Wakes)	4·43	+ 2·23	1·73	10	16	78·6	17	44·0	10	0	0
III.		Hitchen	3·67	+ 1·77	1·15	10	21	77·0	17	46·0	30	0	...
,,		Banbury	4·07	+ 2·01	·90	10	23	80·0	17	44·0	30	0	...
IV.		Bury St. Edmunds (Culford)	2·93	+ ·94	·60	2	19	80·0	17	45·0	1, 31	0	0
V.		Bridport	3·96	+ 1·85	·48	29	20	74·0	18	47·0	31	0	...
,,		Barnstaple	6·01	+ 3·15	·64	29	21	79·5	18	44·0	5	0	...
,,		Bodmin	5·79	+ 2·68	·63	21	23	66·0	28	52·0	1	0	0
VI.		Cirencester	4·31	+ 1·87	·91	10	16	...	...	...	...	...	...
,,		Shiffnal (Haughton Hall)	3·46	+ 1·29	·49	21	27	76·0	16	43·0	31	0	...
,,		Tenbury (Orleton)	3·48	+ 1·10	·56	21	25	76·2	18	41·5	31	0	0
VII.		Leicester (Wigston)	4·28	+ 2·18	·61	3	27	80·0	16	44·0	9, 30	0	...
,,		Boston	3·55	+ 1·25	·48	3, 21	22	81·3	16	47·0	31	0	0
,,		Grimsby (Killingholme)	3·76	..	·66	30	24	77·0	17	40·0	1§	0	...
,,		Derby	4·68	+ 2·49	1·04	30	27	75·0	16	47·0	31	0	...
VIII.		Manchester	...	...	..	...	...	...	..	...	...	...	...
IX.		York	...	...	...	...	...	...	...	...	...	...	...
,,		Skipton (Arncliffe)	9·22	+ 6·02	1·51	25	30	73·0	17	42·0	1	0	...
X.		North Shields	3·79	+ 1·98	·71	29	27	70·3	16	47·5	26	0	0
,,		Borrowdale (Seathwaite)	12·57	+ 4·43	1·70	7	24	...	...	...	...	...	...
XI.	WALES.	Cardiff (Town Hall)	...	...	...	...	...	...	...	...	...	...	...
,,		Haverfordwest	4·99	+ 1·69	·73	21*	17	70·0	16	47·0	9	0	0
,,		Rhayader (Cefnfaes)	6·04	+ 3·19	·53	28	24	69·0	...	44·0	...	..	...
,,		Llandudno	3·33	+ 1·03	·71	4	19	73·6	14‡	49·0	27	0	...
XII.	SCOTLAND.	Dumfries	3·93	+ 1·68	·60	29	25	71·0	11‖	46·5	12**	0	...
,,		Hawick (Silverbut Hall)	3·02	...	·86	4	20	...	...	...	...	...	...
XIV.		Ayr (Auchendrane House)	3·55	+ 1·39	·44	18	28	74·0	13¶	42·0	29	0	0
XV.		Castle Toward	3·94	+ ·80	·80	14	22	...	...	...	...	...	...
XVI.		Leven (Nookton)	3·90	+ 1·63	·51	29	23	72·0	14	43·0	26	0	0
,,		Stirling (Deanston)	5·35	+ 1·95	·87	29	27	72·0	14	38·0	26	0	0
,,		Logierait	4·06	...	1·17	29	23	...	...	...	...	...	...
XVII.		Ballater	3·13	...	·92	29	15	72·5	16	38·0	12	0	...
,,		Aberdeen	3·06	...	·61	23	20	71·1	17	46·6	25	0	0
XVIII		Inverness (Culloden)	4·02	...	·85	31	17	68·9	14	49·2	31	0	0
,,		Portree	10·73	+ 4·66	1·52	5	26	...	...	...	...	...	...
,,		Loch Broom	3·55	...	·36	16	24	...	...	...	...	...	...
XIX.		Helmsdale	3·45	...	·41	25	22	...	...	...	...	...	...
,,		Sandwick	2·83	+ ·96	·49	8	19	68·0	14	45·8	28	0	0
XX.	IRELAND.	Cork	4·67	...	·65	6	28	...	...	...	...	...	...
,,		Waterford	5·02	+ 1·70	·48	28	26	72·0	19	47·0	26	0	...
,,		Killaloe	6·00	+ 2·81	·68	30	31	79·0	16	44·0	27	0	...
XXI.		Portarlington	5·62	+ 2·08	·62	25	29	72·0	16	46·0	28	0	0
,,		Monkstown	5·63	+ 3 20	·73	10	26	...	...	...	...	...	...
XXII.		Galway	6·20	...	·74	7	29	70·0	19	43·0	1, 15	0	...
,,		Bunninadden (Doo Castle)	5·64	...	·76	6	28	66·0	27	38·0	27	0	...
XXIII		Bawnboy (Owendoon)	...	...	.	...	...	...	...	...	..	...	...
,,		Waringstown	5·07	...	·67	5	26	77·0	19	45·0	10	0	...
,,		Strabane (Leckpatrick)	6·42	..	·81	24	28	73·0	16	..	...	...	...

* And 29. † And 19. ‡ And 15. ‖ And 30. ¶ And 14 § And 10, 30. *** And 26.
+ Shows that the fall was above the average ; —that it was below it.

METEOROLOGICAL NOTES ON JULY.

ABBREVIATIONS.—Bar for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; T S for Thunderstorm; R for Rain; H for Hail, S for Snow.

ENGLAND.

LINTON PARK.—Dense fogs on 1st, 10th, and 17th; T on 3rd and 5th; very heavy R on 11th. From 13th to 22nd fine and summer like, otherwise the month has been a dull, cold, and wet one for July, retarding vegetation very much; winds mostly S. and S.W., but the greatest fall of rain on one day, 1·02 in., on the 11th, was from the N.E., confirming the current belief, that when rain does come from that quarter, it comes in large quantities. Winds at noon: S.E. 1 day, S. 10, S.W. 12, W. 4, N.W. 1, N. 2, N.E. 1.

SELBORNE.—T in early morning of 3rd, and T and L at 3.30 p.m.; T and L in early morning of 5th, with heavy showers; 2·00 in. in 24 hours of 10th and 11th; T on evenings of 23rd and 29th; prevailing winds, S., S.W., and W. The last two months (June and July) show rainfall amounting to 3·77 and 4·43 = 8·20 in. Much hay spoiled by the wet, and hops ruined by the blight.

HITCHEN.—Heaviest fall in less than 24 hours for many years on 10th and 11th. Hurricane at 5 p.m. on 29th.

BANBURY.—T S on 4th, 5th, and 23rd, with hail on 5th and 23rd. On 5th a chimney struck by L at the top of the town; a man much injured whilst standing under a tree, which was struck about one mile S. of the town.

CULFORD.—T on 5th, 22nd, 23rd, 24th, and 25th, with H on 5th and 25th. A month of growing weather, somewhat deficient in sunshine, and without any high temperatures for the season, the max. being 80° on the 17th. The cuckoo continued to sing until the 9th, this being unusually late, as its notes are seldom heard here after the end of June.

BRIDPORT.—Wet month and low barometer. No rain on St. Swithin's day. Gale on the night of the 29th, accompanied by very heavy H, R, T and L.

BODMIN.—Average bar., 29·91; average temp., 61°·2. This has been a wet, ungenial month, and though the temp. has been only 0°·8 below the average, there has been a remarkable absence of sunshine for July.

HAUGHTON HALL, SHIFNAL.—An ungenial, wet month, not so much from the weight of rain as from the continuous fall, only four days free from it; the nights unusually cold for the season, the ther. exceeding 55° only on three nights, and on the last night only reaching 43°. The prevailing winds were from S.W., shifting occasionally to W. and N.W. No T S. Hay crops good, but badly got in; turnips and mangold wurzel doing well. Not a wasp yet; the hornets, so abundant last year, have disappeared; scarcely a butterfly.

ORLETON.—A cloudy, rainy month, with very little sun, and generally cold and windy. Rain fell almost every day, but rarely in large quantities; the air generally damp; distant T heard on 1st, 3rd, 4th, 5th, 6th, 8th, 23rd, 24th, and 29th, but never loud or near Temp. about 1¼° below the average of the month.

WIGSTON.—The hay harvest has been much retarded by the wet weather, and but little secured in good condition. The pastures very rich, and the prospect of a good crop of turnips and mangolds is favourable.

BOSTON.—Wet and stormy, with very frequent thunderstorms and heavy rains; weather most unfavourable for hay-making operations, but the crops of hay are very abundant, wheat looking very well, and beginning to change colour about the 18th; much hay uncut or standing in cocks during the last few days of the month. Wheat in flower on the 1st; T S S on 4th, 5th, 9th, 22nd, 24th, and 29th.

KILLINGHOLME.—Very cold and wet month; crops of hay much damaged; harvest coming on very slowly; pastures and meadows unusually full of white clover; ther. has only reached 70° on ten days this summer, and 76°, "summer heat," on one day, the 17th.

DERBY.—A month of almost incessant rain, only five days without it, the fall being more than 2 in. above the mean. The deficiency of 1870 is already nearly made up, notwithstanding the almost drought of the spring months; temp. slightly below the mean. The abundant crop of hay being carried, but in most cases in damaged condition.

ARNCLIFFE.—Much T during month; rain excessive, 1·16 in. in 4 hours on 14th, and total nearly three times the average for July; bar. unsteady all the month.

NORTH SHIELDS.—TS on 1st, 2nd, 10th, 14th, 23rd, and 29th; and T heard also on 4th, 5th, 8th, 13th and 26th.

SEATHWAITE.—There were four days on which the fall exceeded 1·00 in.: 7th, 1·70; 14th, 1·40; 17th, 1·29; and 21st, 1·08.

WALES.

HAVERFORDWEST.—Coldest July since 1847; only one day that could be said to be really warm; constantly wet and at times stormy, the evenings chilly, resembling October; nearly every other day wet. Much of the very slight hay crop spoiled; the green crops look well, and the prospects of the corn harvest good, should fine weather set in.

CEFNFAES.—A cold dreary month; nights frosty; lingering hay harvest and crops light, only 5 dry days.

LLANDUDNO.—The month has been most variable, scarcely two days alike, and seldom more than one or two fine days together.

SCOTLAND.

DUMFRIES.—The month has been showery throughout; day temp. 5°·64 lower than July, 1870, and mean of day and night 3°·5. The crops will be two or three weeks later than last year, but are generally good, except where damaged by wind or R. Fruit is very scarce; country looking fresh and beautiful.

HAWICK.—Rainfall much above the average, and notwithstanding the rather cold nights and mornings, the country looks beautiful, and the crops have a most luxuriant appearance. T on 1st, 2nd, 4th, 5th and 11th; TS, with very heavy R, on 4th, when ·86 in. fell in one hour, many of the house cellars in Hawick were completely flooded, and their inmates terribly alarmed; the thunder shower was quite a local one, and did not extend much beyond the radius of a mile.

AUCHENDRANE.—25 days of rather strong equatorial winds, and an amount of cloud beyond the mean, have marked this July as a month of low bar. pressure and range, low ther., weak evaporation, great rainfall, and high humidity; only one moderate TS disturbed this locality, and R and H fell simultaneously in a very peculiar manner.

CASTLE TOWARD.—There has been much difficulty in preserving upland hay, meadow hay commenced cutting; turnips, potatoes and oats look remarkably well. Bedding plants not flowering very well, in consequence of too much damp and too little sunshine. T at 12.30 on 29th.

NOOKTON.—T on 4th, 5th, 22nd, and 23rd; heavy R on 29th.

DEANSTON.—A very wet month; some R every day except 27th and 31st; distant T on 4th, 5th, 8th, and 10th, and on 30th with L; windy on some days in the middle of the month.

LOGIERAIT.—A very wet month, which has been much against hay-making. However, notwithstanding the unusually heavy rainfall for the month of July, it was needed to compensate for the drought of last year, many of the springs which dried up last autumn are scarcely filled yet. T on 11th, and distant T on 29th.

BALLATER.—Rained more or less during the whole month from the 15th; occasional very heavy peals of T on 11th; very heavy R on 29th.

ABERDEEN.—Bar. corrected 29·671, or 0·224 lower than mean of 14 years. Temp. 58°·1, or 1°·2 above mean, chiefly caused by high night temperature. Rainfall 0·855 above average. Winds generally very light, S.W. and N.W. preponderating. A month of rather damp but genial weather. TS on 5th, between 2 and 3 p.m., and on 23rd; T on 8th at 4 p.m.; 11th, between 12 and 2 p.m.; on 22nd, at 7 p.m., very heavy at Inverruie; on 24th at noon; 26th at 10 a.m.; 28th at 12·30 p.m., and on 30th at 2 p.m.

PORTREE.—A very wet month; a heavy shower of R and H on 5th from 1.45 to 2.15 p.m.; rain gauge measured 1·32 inches; all the streams were swollen in a few minutes to a fearful size; all the low lying ground was completely flooded, but no serious damage done to the crops.

LOCHBROOM.—This month has been a contrast to the preceding three, being constantly wet (though the amount of fall was not great), whereas they were remarkable for their dryness; crops look very well, but hay suffers from the wet.

SANDWICK.—July has been wetter and warmer than the mean, and this has

advanced vegetation after the previous protracted drought. I hear there were three waterspouts, but only saw that on the 21st, of which I enclose a sketch, then and for some days after, the rain poured down in some places near, while very little fell at this station; in one parish a great quantity of S fell on the 21st; distant T on 8th and 9th; a waterspout at 2 p.m. [Engraving in our next. ED.], and T at 7 p.m. on 21st.

IRELAND.

KILLALOE.—The rainfall in the present July (6·00) the greatest in 26 years, except in July, 1861, when 6·51 was measured.

MONKSTOWN.—An extraordinarily wet July; T on 8th, 10th, 23rd and 29th, accompanied by very heavy R and H, which lay in drifts for hours.

DOO CASTLE—Incessant R this month; much T and wind, and S.W. winds caused a continual downpour; the month seemed to reserve its strength for the 29th, when the T and L were awful, a flash of L and a single shot (as if a park of artillery were discharged) were simultaneous, and then a peal followed which shook the slates upon the houses, and burst open doors, which kept swinging to and fro. H in some places fell as large as the largest gooseberries, and seriously damaged several fields of oats and plots of cabbages. Where grass was bare the fields were white with the H. No damage to life or property in this locality. Despite all this R the oat crop will be short, and meadows poor. There was too little sun, and the constant rain reduced the temp. very much. The potato crop promised well and looked blooming to the middle of the month, but since then the blight has made fearful ravages; as a rule potatoes will be small. Turf is still on the ground, and will so remain if there be not immediate fine weather.

WARRINGTON.—Constant R, with low temp. Hay crop greatly damaged, other crops looking well. T on 1st, 7th, and 29th.

LECKPATRICK.—Incessantly wet month; R very useful to oats and turnips, but too late for flax and hay.

HOW OUGHT THE MIN. TEMPERATURE TO BE ENTERED?*

Being solely desirous that what is best should prevail, we never think of checking a discussion, however adverse it may be to our own views—thus it was with the above subject. At page 205 of our last volume we wrote—"The minimun temperature indicated by the thermometer when read at 9 a.m. is the minimun of that day, and is always to be so entered." We should not have presumed to write thus positively if the matter were open to doubt, but we only wrote in a few words the spirit of the instructions of the British and Scottish Meteorological Societies, of the Admiralty Manual, and of every book of instructions we have ever seen. Of course it is easy to imagine cases in which the rule will fail, and our January number teemed with them, but the other side of the case was presented in February, and we have only had one letter since. Looking over the whole series of letters, we doubt if any one would arrive at the conclusion that an entire change in the practice of the meteorological world is required, and if not, could we too strongly urge conformity to the existing rules of the various societies? Dr. Burder, and one or two other correspondents, point out the danger of making one extremely cold morning into two from the proximity of 9 a.m. to the epoch of min. temp.—a perfectly valid objection, but hardly sufficient to demand a revolution, especially as most persons who record minima record also the actual temperature at the time of observation, which, of course, throws a great deal of light on the cases he has supposed.

* See *Met. Mag.* for January and February of the present year, since which time this note has been waiting for insertion.